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**HAZARD PREVENTION AND CONTROL
IN THE WORK ENVIRONMENT**

**PREVENTION AND CONTROL
EXCHANGE (PACE)**

A DOCUMENT FOR DECISION-MAKERS



World Health Organization
Office of Occupational Health
Division of Health Promotion, Education and Communication
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PREFACE

The protection and promotion of workers' health can only be ensured through a multidisciplinary approach, which must include actions on the work environment to anticipate, identify, evaluate and control* health hazards. The links between the promotion of worker safety and health and the minimization of environmental pollution must be recognized and addressed.

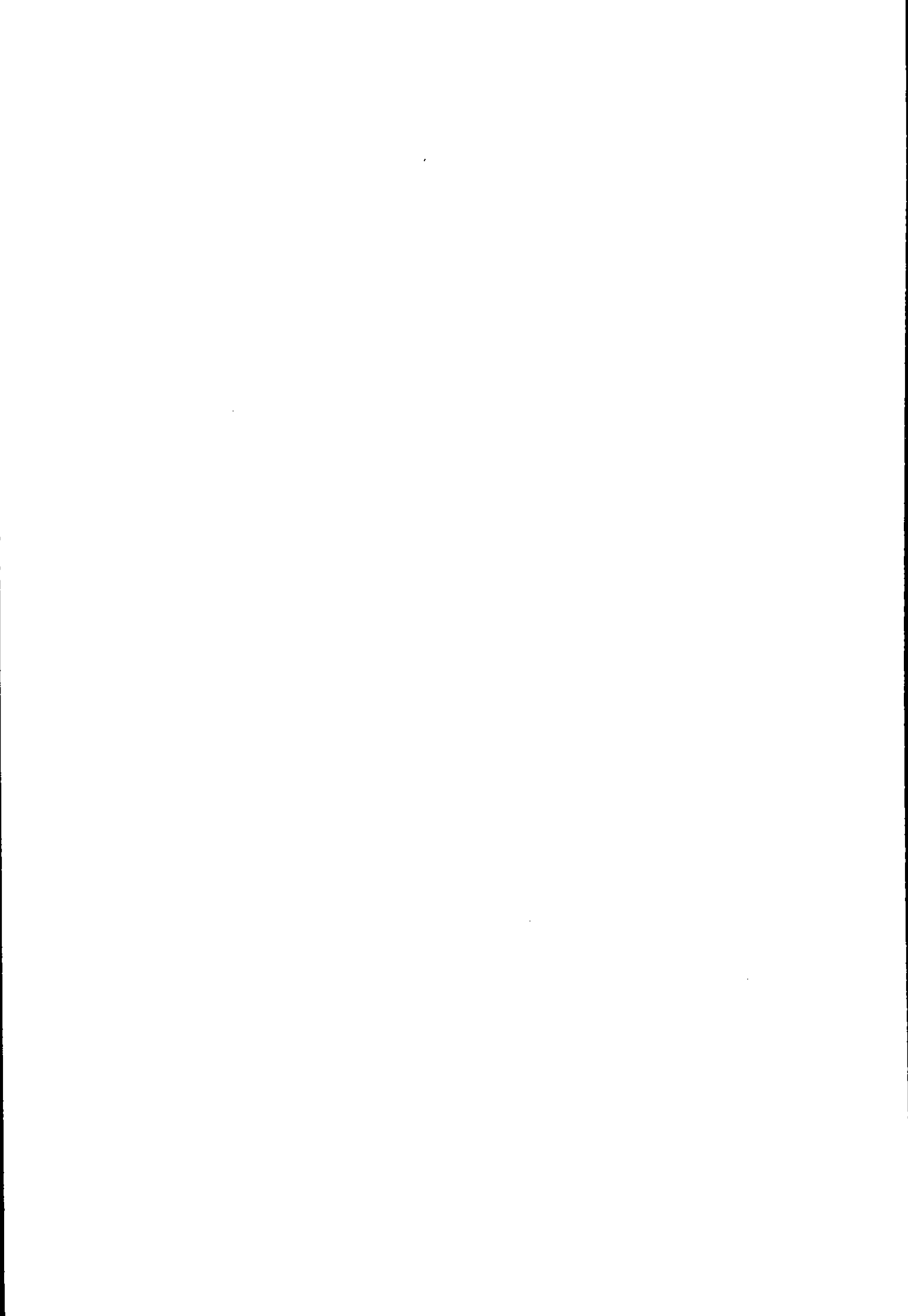
There is technical and organizational knowledge available today that, if applied, could prevent and control most occupational hazards. However, on a worldwide basis, "healthy" work environments are still the privilege of a few, as too many workers continue to be exposed to, often very serious, occupational hazards, and, the general environment continues to be polluted, including by large scale disasters.

The magnitude of workers' health problems worldwide is certainly much greater than it is generally supposed, as would be the benefits resulting from their prevention. In addition to the priceless health benefit, prevention of occupational hazards also brings reduction of costs incurred by health and social security systems in connection with occupational diseases, incapacity and death, as well as the indirect benefit of better morale, productivity and quality, all of which has a bearing on the socio-economic development of countries. Sustainable development also depends upon appropriate action at the workplace. Moreover, it has been demonstrated, through actual case-studies, that investments towards safer and less polluting technologies have brought enormous financial savings. In many instances, controls have led to avoiding losses of expensive and toxic contaminants thus reducing costs while protecting workers' health and the environment.

The application of the available knowledge on hazard control technology to actual workplace situations, in terms of appropriate and effective solutions, adapted to the specific conditions in which they will be implemented, must be further promoted. The wide dissemination of such solutions to where they are needed is also essential. Even in developed countries, it has been recognized that there is the so-called "knowledge-application gap" and that an important reason for the failure in controlling health and safety risks is largely an inability to apply existing knowledge rather than an absence of appropriate knowledge (Swuste and Hale, 1992).

It is essential to promote understanding of the importance of preventive strategies and control technology (primary prevention) in occupational hygiene.

* Control refers to means and technology to reduce or eliminate occupational hazards.



Occupational health programmes and services should give due importance to primary prevention in relation to exposure assessment and monitoring, which although essential components of occupational hygiene practice, can only disclose or confirm but never prevent exposure. There often is more interest in identifying and evaluating occupational exposures and their consequences, than in actually preventing them. Therefore, it is important to promote a comprehensive occupational hygiene approach.

Observations in many countries reveal that common constraints to the effective implementation of adequate control strategies include insufficient awareness, education and political will, shortage of adequate human resources (particularly occupational hygienists with "know-how" on primary prevention), deficiencies in information/access to information and in communication among professionals and institutions, as well as a failure to involve workers and their representatives directly in problem solving.

In its efforts to protect and promote workers' health worldwide, the WHO Office of Occupational Health carries a number of activities aimed at overcoming the above constraints. One specific activity was a meeting on "Hazard Prevention and Control in the Work Environment", held in WHO, Geneva, 19-21 September 1994, with the objective of launching an international action in this field, in order to promote collaboration, avoid duplication, strengthen existing programmes and build national capabilities. The list of participants to this meeting is presented in Annex I.

This document aims at motivating decision-makers at different levels: in donor agencies and international organizations; at the national level, particularly persons in a position to influence national legislation and the allocation of resources to preventive programmes; at the workplace level, including managers, production engineers, supervisors and workers, all of whom are instrumental in promoting and implementing effective primary prevention measures, and in institutions including universities and training centres.

Moreover, it has been demonstrated, through actual case-studies, that investments towards safer and less polluting technologies have brought enormous financial savings. In many instances, controls have led to avoiding losses of expensive and toxic contaminants thus reducing costs while protecting workers' health and the environment.

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SECTION I: INTRODUCTION

SOURCES OF OCCUPATIONAL HAZARDS AND THEIR ADVERSE HEALTH EFFECTS

Work can be dangerous to health and well-being. Depending on the particular job and industrial/manufacturing/service sector in which a worker is employed, one or more of the following hazards may be present:

- (1) Chemical hazards, such as toxic and carcinogenic chemicals, fibrogenic dusts and fibres, which may involve inhalation, skin absorption and ingestion;
- (2) Physical hazards, such as noise and vibration, extreme heat and cold, ionizing and non-ionizing radiation (e.g. UV, electromagnetic fields), abnormal pressures;
- (3) Biohazards, such as bacteria, molds, toxins, virus (e.g. those causing Hepatitis B or AIDS) and parasites;
- (4) Ergonomic hazards, such as repetitive motion capable of causing cumulative trauma syndrome;
- (5) Psychosocial stresses (including unsocial/excessive hours)
- (6) Safety hazards, such as those posed by moving machinery, slippery surfaces, sharp metal or wood surfaces, exposed electrical lines, and potentially explosive materials.

Examples of diseases resulting from such occupational hazards include: silicosis from inhalation of free silica-containing dusts, asbestosis and cancer from asbestos inhalation, impairment of cognitive ability and damage to the bone marrow from lead absorption, and leukaemia from excessive benzene inhalation. There are emerging problems such as psycho-organic syndrome due to solvents, and carpal tunnel syndrome due to repetitive hand movements. The list of adverse health effects resulting from exposure to chemical, physical and other potential hazards at work is extensive. The ILO Convention No.121 contains a list of occupational diseases (ILO, 1964-1980).

Well known occupational diseases, such as silicosis, lead poisoning, intoxications/poisoning by pesticides and solvents, continue to affect workers' health, working capacity, and productivity throughout the world, but nowhere do they leave greater impact than in developing countries where their importance is easily overlooked in view of other urgent health problems associated with poverty, lack of water and sanitation, malnutrition, overpopulation and the presence of endemic infectious diseases, and where workers are frequently poorly trained and badly organized.

According to the ILO (based on and extrapolated from received statistics), the current global estimates for occupational injuries are 125 million/year, and 220,000 fatalities/year. The differentiation between occupational accidents and diseases is difficult as some countries report only accidents as "accidents" and others report both accidents

and diseases as "accidents". Agents causing chronic, or long-term damage to the body are responsible for an estimated 100,000 new cases of occupational diseases in the USA alone each year, and untold numbers elsewhere in the world.

An estimate of the annual number of occupational diseases based on the Nordic countries incidence rate, leads to the belief that in the American Region, the number would range from 1.1 million to 2.5 million; in South East Asia, from 1.7 million to 3.9 million; and in the Western Pacific Region, from 2.5 million to 5.6 million. However, considering extensive under-reporting in developing countries as well as much worse working conditions plus aggravating factors the global annual estimate would be from 68 to 157 million cases of occupational and work-related diseases (Mikheev, 1994).

As to the European Region, the estimate is about 2 million cases per year. Although there is, even in Europe, much under reporting of occupational diseases, it is recognized that the most frequent are noise-induced hearing loss, chemically-induced dermatoses, asthma caused by organic dust, and inorganic dust-induced pneumoconiosis, as well as musculoskeletal disorders. During the Second European Conference on the Environment and Health (Helsinki, June 1994) an estimation was made that about 16 million workers may be exposed to carcinogenic agents in Europe.

The real extent of diseases and health impairment resulting from occupational exposures is unknown as the cause/effect relationship is not always established.

Any estimate concerning the number of occupational diseases is often an under estimation, as the reported cases are usually the "tip of the iceberg". The large number of reported cases of occupational diseases constitute a very small sample of what really occurs because very few reach medical services, and, even fewer reach medical services that can recognize and report the health impairment as resulting from an occupational exposure. As an example of under-diagnosis and under-reporting, mention can be made to a study, in Brazil, among 30 sugarcane workers (who utilized a mercurial fungicide) which revealed 21 cases of mercury poisoning with high mercury blood levels (as high as 250 $\mu\text{g/L}$, while the ACGIH TLV is only 15 $\mu\text{g/L}$), in a state where, for that year, only one occupational disease had been reported (Frumkin and Camara, 1991).

In general, the less intense the exposure (for example, the lower the concentration of a chemical in the air to which the worker is exposed, or the lower the intensity of a physical agent), the lower the potential for health impairment and disease development. Therefore, adequate interventions at the workplace level, in order to eliminate or reduce hazardous exposures and conditions, can prevent or minimize such adverse consequences. This is the task of occupational health and safety professionals, particularly occupational hygienists. However, this is a complex task and it is not always easy to design control solutions which are effective, efficient and feasible, hence collaborative efforts in this respect, must be promoted. Moreover, a clear dose-response relationship does not always

exist, and in certain cases even single exposures can have serious consequences.

It is hoped that the Prevention and Control Exchange (PACE - described in Section III) will contribute to avoid/eliminate unacceptable occupational exposures, by sharing effective preventive solutions, thus making them available to those responsible for such interventions at the workplace level. PACE will indicate "this has worked in analogous situation(s) and may work for you".

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SECTION II

WHAT DO WE MEAN BY PREVENTION AND CONTROL?

Introduction

Much is known about the occurrence and harmful effects of hazards originating in the work environment. Nonetheless, an unacceptable number of occupational diseases, accidents and undesirable impacts on the environment, still occur in many countries. Hazards and risks in the work environment should be dealt with systematically, through an efficient safety and health risk management. In the technologically advanced sectors of industry, applied solutions and control measures have usually undergone the test of experience. However, in the technologically less developed sectors of industries, control measures, if used, are usually less or not at all effective. This is not so much a result of the absence of appropriate knowledge, but rather an inability to apply existing knowledge and experience.

What do we mean by Prevention/Control?

Prevention and control of occupational hazards can take place at various levels. Table I summarizes the different types of preventive measures. Occupational hygienists are usually responsible for developing strategies for prevention and control of occupational hazards which include engineering controls, work practice improvements, administrative controls and personal measures to eliminate, or at least minimize, the risks that have been judged significant in the environment they have evaluated. It should be stressed that hazards should be controlled preferably at their source by eliminating or reducing the risk; this includes changing work processes, modifying equipment and using different raw materials. The next group includes control measures taken at their transmission path (as close as possible to the source); this includes enclosures. Although preventive measures at the worker level constitute the last group in the hierarchy of controls, certain measures in this category are indispensable components of any preventive programme (e.g. adequate work practices, education and training).

Ideally, the best approach is anticipatory preventive action, which should include:

- occupational and environmental health impact assessments, prior to the design and installation of any new potential source of pollution (industry, energy production, agriculture and food production, services);

- selection of the most suitable and safe technology (the least hazardous as well as the least polluting);
- environmentally appropriate location;
- proper design, including the required control technology and provision for safe handling and disposal of the resulting effluent and waste, and
- elaboration and implementation of guidelines and regulations for training on the correct operation of processes, including safe work practices, emergency procedures, and maintenance.

In the practice of occupational hygiene, the overall sequence of various activities is analyzed, tasks and operations are evaluated, and control measures are recommended.

For best efficiency, such measures should be integrated into a hazard prevention and control programme, under competent management, emphasizing teamwork (occupational hygienists and other occupational health and safety professionals, production engineers, managers and workers) and including clear objectives and policies, assignment of responsibilities, establishment of lines of communication, proper training (where necessary, retraining) of workers and managers, as well as joint workers/management health, safety and environment committees.

The correct operation and maintenance of the control systems is of utmost importance and should be evaluated regularly as to its effectiveness. Aging equipment and lack of maintenance are well-known causes of malfunctioning control measures. Also, in the design and operation of control measures the environmental impact should be taken into account. Problems should not be transferred from the occupational setting to the general environment.

The implementation of control measures should be supervised and their efficiency evaluated. The evaluation of control measures should be part of the programme management and should include:

- environmental surveillance (which provides data on occurrence and magnitude of exposures)
- health surveillance, including, whenever necessary, feasible and acceptable tests for biological monitoring (which provides the absorption of chemicals) and early detection of health impairment.

Whenever epidemiological assessments are carried out, they can provide useful indications which should be considered.

Table I - Types of Preventive Measures

Control at the Source:

- elimination
- substitution (materials, equipment, processes)
- modification (equipment, processes)
- maintenance of machines and equipment
- other controls such as wet methods

Control in the Transmission Path:

- enclosure, closed systems
- isolation (at the source, beyond the source, of workers)
- ventilation: local exhaust
- ventilation: general (displacement, dilution)

Control at the Worker Level:

- work practices and organization
- education and training (including emergency response)
- personal protective equipment
- limitation of exposure time
- personal hygiene

Other means related to the Work Environment:

- adequate lay-out
- good housekeeping
- adequate storage and labelling
- warning signs, restricted areas

The Control Step in the Practice of Occupational Hygiene

The growing awareness on occupational hazards and, specifically, on exposure to toxic substances in the workplace, has resulted in an impressive body of knowledge on the recognition and evaluation of chemical hazards. Less attention has been given to preventive actions; nevertheless there is much theoretical knowledge in this field, the main problem being its practical application.

In many countries, legislation has mainly focused on the setting of standards for exposure to hazardous substances at the workplace. Measurements for compliance to these standards have been used, by governmental bodies and occupational hygiene professionals, as the main instrument towards the control of working conditions. The broad range of possible control measures has usually remained beyond the scope of legislation. Moreover, the attention of occupational health professionals has often (and inadequately) been limited to preventive measures such as personal protective equipment and industrial ventilation techniques.

A systematic approach for the reduction of occupational exposure to hazardous substances was not developed into legislation until recently and only in a limited number of countries. A good example of an international directive in this respect, is the Council Directive 90/394/EEC, which aims at protecting workers from risks related to exposure to carcinogens at work. This Directive states that employers should avoid or reduce the use of carcinogens at the workplace by replacing them, in so far as is technically possible, with substances not as dangerous or less dangerous, using them in closed systems, reducing the quantities of carcinogens used, keeping the number of workers exposed as low as possible, designing work processes and engineering control measures, adopting suitable working practices and methods as well as providing hazard information for workers, among other measures. Such guidelines in fact instruct employers and facilitate their job during the planning of preventive strategies.

Searches in the specialized literature reveal that even more attention should be paid to control measures. Reports on risk assessment and monitoring definitely outnumber those concerning the implementation of control measures.

A search in the computer databases of ILO, HSE and NIOSH showed that the key words "control", "control measures" and "control strategy" were frequently mentioned in references, but were predominantly used in the context "control measures are needed" or "controls are advised". Only a few papers reported exposure concentration measurements before and after the implementation of controls (Buringh et al., 1992).

The limited attention given to measures to reduce the sources of emission may be illustrated by an investigation of the Dutch Labour Inspectorate (Table II). This investigation concerned 140 companies in the following sectors of industry: leather products, transport, metal products and the electroplating industry. 76% of the control measures consisted of supplying personal protective equipment and local exhaust ventilation, whereas 21% of the measures were taken at the source of emission. The remaining measures relied on separating workers and source (Spee et al., 1990).

Table II: Application of preventive measures to control occupational exposure to hazardous substances in 140 different companies in The Netherlands

	Types of Measures	%
I	Reduction of the source	21
II	Local Exhaust Ventilation	27
III	Reduction of exposure (at source)	3
IV	Personal protective equipment	49

Clearly a systematic approach to control measures was lacking in the majority of the companies which demonstrates many possibilities for improvement. Four important reasons for the predominant position of personal protective equipment as a control measure were:

- lack of adequate expertise in primary prevention in the companies;
- lack of exchange of technical solutions among companies;
- lack of attention for working conditions at the design stage of the process;
- the widespread and easy availability of personal protective equipment.

The types of measures (mostly adopted in the surveyed companies) have been shown to be quite costly to the companies, not only in terms of initial cost, e.g. purchasing of equipment, but also as high energy bills in the case of local exhaust ventilation. Personal protective equipment, often seen as the cheap alternative, is not necessarily so; in addition, its efficiency to protect workers is often doubtful (not to mention the discomfort and physiological costs particularly in the case of masks) and its contribution to the protection of the environment is nil.

Controlling the source of emission, apart from being more effective, can also be financially beneficial. Source control solutions interact with the production process itself and may therefore have a beneficial effect, since they lead to a higher degree of control of the process flow and logistics. Some solutions also result in appreciable savings in raw materials by reducing losses (closed systems, recycling). There is a positive link among the quality of the production process, the quality of the product and the quality of working conditions.

The Concept of Risk Management

Risk management in the work environment is a broad concept which refers to decisions and actions that aim at preventing or reducing occupational hazards to

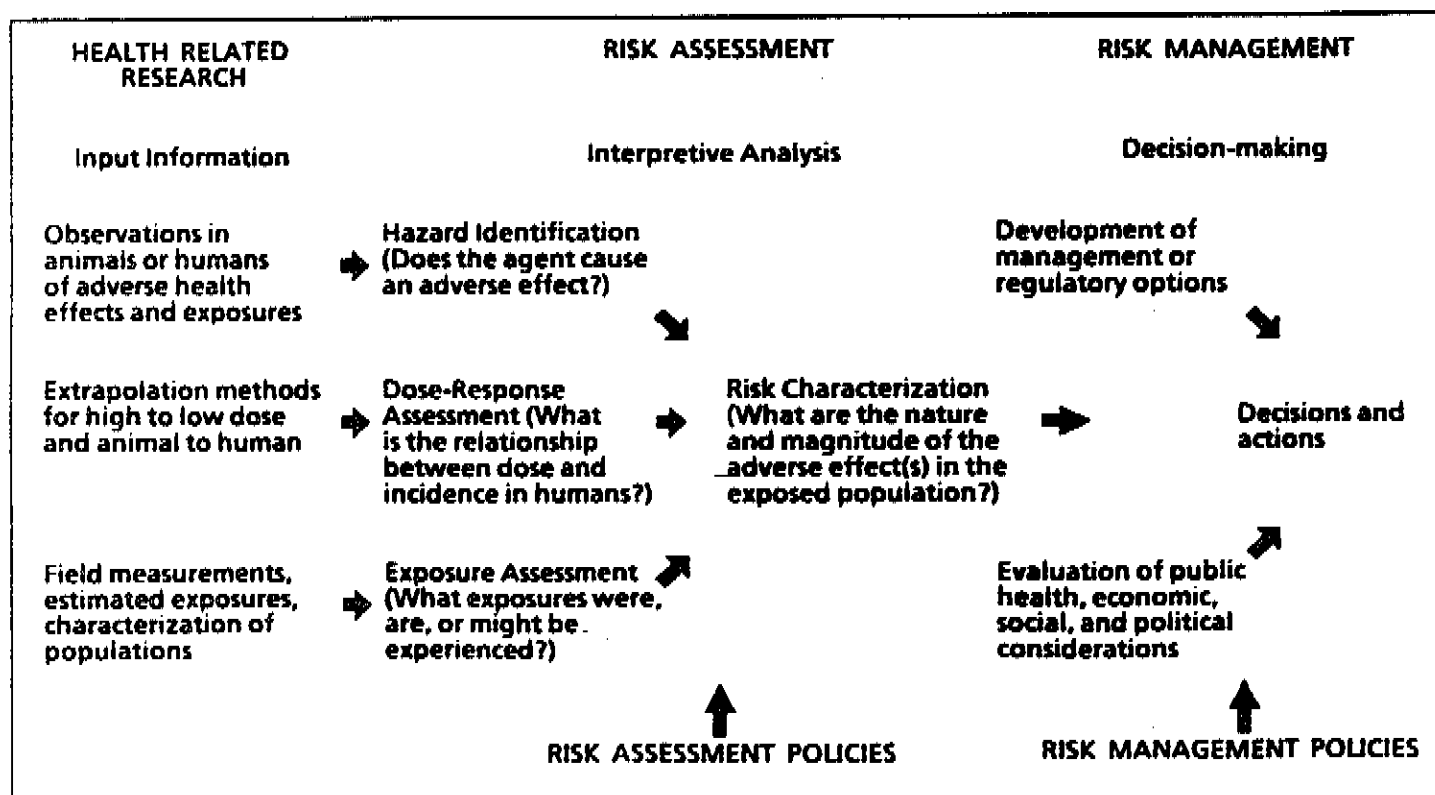
acceptable levels, also considering the surrounding communities and environmental protection, taking into account the socio-economic context.

Working conditions used to be perceived as problems requiring solely technical solutions, surveillance and personal protective equipment. However, working conditions are increasingly being regarded as management issues and have become an area of scientific research as well. Management has the task to prevent accidents and occupational diseases. This requires a systematic approach.

Recent research developments in the field of occupational health and safety have explored the risk management aspects. The classical attitude of attributing all problems either to technical failures or to human errors has been losing ground (Hale and Glendon 1987, Reason 1990, 1991, Poyet and Leplat 1993, Wilpert 1993) in favour of a broader risk management approach where other factors are also considered. This has been triggered by major accidents in complex and well defined technologies, like the nuclear industry, the chemical and oil producing industry.

Several models have been suggested to differentiate between the various elements necessary for a sound risk management. Figure 1 presents elements of risk management, and relates it to risk assessment and health related research. (Cothorn et al. 1988).

Figure 1: Elements of Risk Assessment and Management*



* Cothorn, C., M. Mehlman and W. Marcus. *Advances in Modern Environmental Toxicology*. Volume XV "Risk Assessment and Risk Management of Industrial and Environmental Chemicals". Princeton Scientific Publication Co., Princeton, New Jersey, USA. (1988)

Although Figure 1 places risk assessment and risk management into perspective, it should be kept in mind that other types of information than "health related research" play an important role in risk management. Occupational health problems can be, and very often are, job- or plant-specific and important in-puts are provided by those involved with the specific work process and organization, including production engineers and workers/management health and safety committees.

The information (i.e. the health-related research, establishing relationships between exposure and health effects), and the interpretative analysis required for risk assessment are the domain of science or applied science. Risk management, on the other hand, involves decision-making and action, thus falling outside this field and belonging to the socio-technical area.

During the last decades, in many companies, quality assurance has been developed into a quality management system, often based on the ISO 9000 series. This approach has also been adopted, by some, for the management of safety and health. A safety and health management system can be defined as a management system that determines and implements safety and health policies and consists of an organizational structure, responsibilities, procedures, processes and resources for the identification and control of safety and health risks (in analogy with ISO 8402).

The purpose of this management system is to manage systematically (structuring) and to improve the functioning of the organization. Structuring means making and documenting agreements. Important documents are:

- a policy statement;
- safety and health tasks and responsibilities;
- the safety and health communication structure, including a programme for risk identification and control, an action plan and its evaluation;
- procedures, and
- instructions.

The first component of a management system is a policy statement which declares the commitment of senior management to occupational safety and health. In the policy statement the organization commits itself to specific goals in the prevention of accidents and occupational diseases.

The achievement of these goals is ensured through the assignment of tasks and responsibilities for the different levels in the organization, a clear safety and health communication structure (top-down and bottom-up) and a planning and control cycle (Yearly Safety and Health Plan and Report). An important mechanism to ensure communication and collaboration on occupational health and safety matters, among all concerned, is provided by joint workers/management health and safety committees, which

should have clear objectives, well-selected representatives and a definite work and evaluation schedule (how often it meets, how its decisions are implemented and followed up).

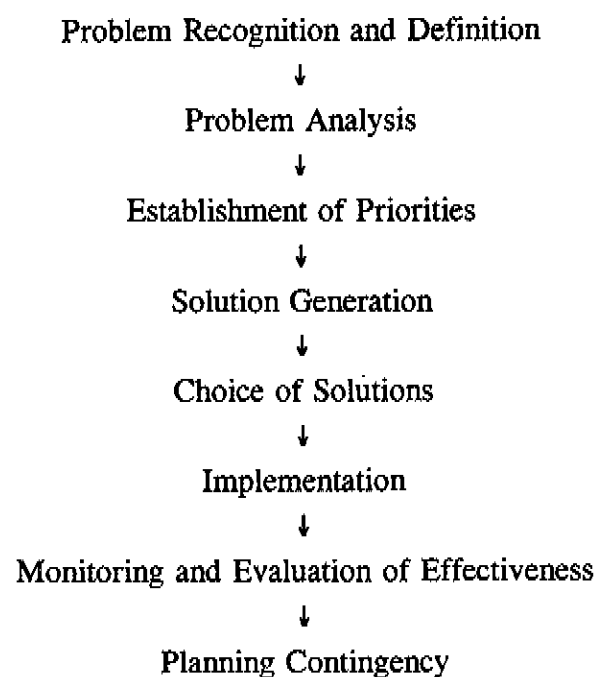
Important organizational processes are regulated by written procedures. Procedures are the link between the organization and actions (processes). Procedures indicate "who does what, when and how" and gives the assurance that the organization will meet adequate safety and health requirements. Important procedures include:

- purchase and introduction of machines, tools, raw materials and other substances (e.g. for cleaning);
- introduction of new personnel;
- education and training;
- record keeping;
- emergency response, and
- waste disposal.

Hazard prevention and control programmes should be incorporated into the management system and should involve from risk identification and establishment of priorities to implementation and evaluation of control strategies.

In quality management, the so called Demming Circle (Plan, Do, Check, Adjust) is the basis for "identify and solve" quality problems. As a variant of this approach, the risk assessment and control cycle (Hale, 1992) can be used to solve safety and health problems.

Figure 2: The Problem Solving Cycle



The cycle starts with the recognition of a safety and health problem as a result of a comparison of the current situation with the ideal situation (according to safety and health criteria).

The problem cause and effects are analyzed (for instance, by exposure identification and assessments) and factors which facilitate or block the effect are identified.

A proper definition of the problem is essential; questions to be asked are what is the magnitude of the risk? which are the effects on workers' health? who is exposed to the risks? The second step is to analyze the background of the perceived problems; what are the reasons for the current work processes and techniques that give rise to the problem? which factors hamper the modification of existing work practices? which factors may facilitate improvements?

The possible solutions with different priorities which arise out of the analysis are reviewed. The chosen solutions are implemented. In the evaluation, the effectiveness of the solution is compared with the criteria set in the earlier stages, and adjustments are made to maximise this effect. Finally the solution is documented and incorporated into the safety and health management system.

The most critical steps in this control cycle are, the generation and choice of solutions, as well as their implementation. Implementation means change, and, in order to promote the positive attitudes required to accept such change among the concerned persons at the workplace level, two approaches are suggested:

- to involve concerned persons in the company (e.g. managers, workers, production engineers) in the process of finding solutions for existing problems; and
- to demonstrate that change will improve workers' health and well-being, as well as help the company to better achieve its own goals.

In fact, the first approach is necessary for the design of any successful preventive strategy because this requires teamwork involving all concerned persons.

In both approaches, it is important that the proposed solution be seen as practically achievable. Once an occupational hazard is clearly recognized and assessed, the possible solutions to prevent it should be considered without too many restrictions (e.g. financial ones), if they are to have any influence at all.

Generating and Discovering Solutions

Solutions can be generated in different ways. The expertise of occupational hygienists is the starting point. Unfortunately many professionals look at a work process as something "unchangeable" and intervene primarily with measures such as exhaust ventilation, or personal protective equipment, or work practices, leaving the production process unchanged. Solutions, such as substitution of materials or process modifications, which may be applicable and which may reduce the need for more complicated preventive measures (e.g. enclosures and exhaust ventilation), are not always explored.

Moreover, considerations concerning possible solutions and control measures are very often limited to the category of "add-on" or "retrofit" measures. Even local exhaust ventilation for chemical hazards and enclosures for chemicals and noise, which are known examples of solutions usually implemented as "retro-fitting", would be easier to install if they had been foreseen in the initial project. For these reasons, it is important to emphasize the "anticipatory preventive action", in order to avoid difficult and expensive retro-fitting.

Furthermore, production processes can be changed. For logistic reasons, machines and installations may be moved within or among production units, new investments may generate radical changes in the production processes, or new production lines may be started. Occupational hygiene and safety professionals, as well as workers and their representatives, should participate in any process change or modification, so that adequate health and safety principles are developed and introduced at an early stage.

Next to the professional experience, a second possibility is "discovering" (or identifying) already existing solutions and control measures. By this it is meant "to discover" a solution which has already been applied somewhere else in a cost-effective way. Professional literature and contacts with colleagues are a possible source for information. Important recent developments in information dissemination include initiatives to provide information on preventive measures in an abbreviated, eventually electronic format, the so-called "Solution Databases". In Sweden, The Netherlands, Great Britain, Italy, Australia, Canada and the USA, many such databases are in an experimental stage; however, some database prototypes have already been developed (Swuste and Hale, 1994).

The databanks provide condensed information, descriptive in nature, no more than two to four pages, with considerable emphasis on graphic presentations of the solution. The information is easily accessible to a wide group of interested persons. Information on the effectiveness of the solution, when given, is provided either as an exposure measurement from a "before-after" comparison, or as a qualitative assessment based on expert opinion.

A recent initiative in Europe has proposed a navigation system for a databank to ensure the transferability of solutions between various branches of industry and to give preference to solutions which control the hazard at its source.

The navigation system has two potential entry points corresponding to two basic types of solutions. Firstly, an entry point based on the production process, with the classification according to unit operations or basic material flow, if the objective is to substitute by safer methods of production. Secondly, an entry point at the emission and transmission paths for more conventional occupational hygiene control measures.

The classification of production processes facilitates comparisons among solutions which were designed for different industries and workplaces. In the near future, the proposed navigation system will be implemented and properly tested to investigate its usefulness; this work has been stimulated by the Directorate-General for Employment, Industrial Relations and Social Affairs (DG-V), of the European Union.

During the generation of solutions, experiences from other workplaces and the use of pilot projects can increase the chances of success. There is a need for international collaboration to disseminate the existing information sources and databases, as well as to promote exchanges of knowledge and experiences among professionals searching for solutions to prevent and control workplace hazards. For this reason, mechanisms for such exchanges will be promoted through PACE, described in Section III.

Control Measures in Training and Professional Development

Although prevention is an essential component of the broad field of occupational health, occupational hygienists constitute a core professional group in what refers to controls at the workplace. Therefore, this group is hereby specifically addressed.

"The goal of occupational safety and health engineering is to prevent occupational disease and injury, by the adequate management of the work environment. The operating principle is to systematically protect workers against safety and health hazards through techniques that do not place the burden of protection on the worker". This statement was made at the Engineering Control Technology Workshop at the University of North Carolina (NIOSH 1983). This technical approach towards occupational hygiene has been dominant from the beginning of the profession in the USA. For a long time, in the USA, students in occupational hygiene have received academic training in subjects which include not only toxicology, physiology, and exposure assessment - but also industrial design sciences and aspects of mechanical engineering (Hatch, 1960). The emphasis on control measures to reduce the emission of, or the exposure to, work environment hazards should continue and even be increased.

The WHO document "Occupational Hygiene in Europe - Development of the Profession" (WHO, 1992) states that the control of occupational hazards is the key activity in the paradigm of the profession, next to the anticipation, the recognition and the evaluation of health hazards in the workplace.

The need to develop effective control measures, taking the production process, the work practices and the work environment as points of entry, should always be strongly stressed in any training programme or professional development session for occupational health and safety professionals, particularly occupational hygienists. Unfortunately, what is taught in courses is often too theoretical, hence not easily applied in the day-to-day practice of occupational hygiene; pragmatic approaches need to be further promoted.

More emphasis should be given to the control of hazards during the design phase of a machine, a process or a workplace: it is therefore important that the professionals responsible for such design be educated as to the principles of health and environmental protection (including sustainable development), or that they work in collaboration with specialists in these fields.

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SECTION III: WHAT IS PACE?

PACE = PREVENTION AND CONTROL' EXCHANGE

An International Collaborative Action on Hazard Prevention and Control in the Work Environment

Introduction

Occupational hygiene and safety professionals are dedicated to the anticipation, recognition, evaluation and control of hazards in the work environment. It has been long recognized that prevention and control of hazards (particularly the health hazards) have not received, overall, the level of professional attention given to hazard recognition and evaluation. With this premise in mind, the World Health Organization (WHO) convened a meeting of international experts in this field to stimulate the adoption of practical prevention and control measures as a priority in the workplace in order to promote effective protection of workers' health.

The problem of lack of implementation of appropriate control strategies and technology is common to both developed and developing countries. In many cases solutions are available but those who need to use them are unaware of the possibilities. In other cases the options are well understood but there is still considerable resistance to their adoption. Transfer of information on appropriate control technology is necessary to develop sound occupational hygiene practices throughout the world. This flow of information can greatly contribute to the efficient and effective implementation of feasible solutions to control health hazards in workplaces everywhere.

A related issue is the transfer of technologies, including processes, machinery and equipment, which should be appropriate and safe for workers and the environment. It should be kept in mind that "the best occupational health and safety practice anywhere should be followed everywhere". Although the actual transfer of technology is beyond the scope of PACE, it is mentioned here with the objective of promoting awareness on its importance in relation to occupational health, safety and the environment. The ILO has a Code of Practice concerning this subject (ILO, 1988)**.

* Control refers to means and technology to reduce or eliminate occupational hazards.

** ILO Code of Practice on "Safety, health and working conditions in the transfer of technology to developing countries", (1988), International Labour Organization, Geneva.

The PACE initiative, emphasizing the development, dissemination, selection and implementation of appropriate technology will create a formidable approach towards the overall strengthening of preventive and control strategies for health hazards in the work environment, by improving knowledge, awareness and capability in this field. The programme is structured in a way that it does not interfere with existing programmes; it is rather intended to support them where they exist, whilst breaking new ground where they don't.

The Purpose of PACE

The PACE programme is designed to promote awareness concerning the need for prevention and control as the priority element of practical occupational health programmes. It is also intended to strengthen national capabilities for the utilization of successful approaches to the prevention and control of health hazards in the work environment. It will achieve this by promoting the exchange of existing knowledge, the transfer of appropriate control technology and the development of human resources.

The Scope of PACE

Needs have been identified in a number of areas. In general there is a desire for simple, well-presented and readily available information on practical control measures. Educational materials are needed to illustrate the practicability and effectiveness of these control measures. Ideally, the material should be in the form of videos, slides and similar visual material as well as concise case studies and appropriate written guidelines. The PACE programme aims at promoting communication, information, understanding and action by all means.

Initially, the PACE programme will address the control of chemicals and the management systems needed to ensure proper implementation of preventive measures in the workplace. It is foreseen that, in the future, the programme will expand to include other factors, such as physical agents, biological agents, psychosocial factors and ergonomic stresses as well as legislation. Although this programme is directed towards occupational hygiene, safety and environmental concerns will be given consideration in the selection and choice of appropriate control technology measures.

Organization and Implementation of PACE

A Steering Group has been created under the leadership of WHO to coordinate the PACE programme (see Annex II). This multi-disciplinary group benefits from the expertise of members from wide ranging backgrounds. Professional expertise in occupational health and safety, and environmental affairs, is supplemented by experience

stemming from education, government and commerce. There are representatives from developed and developing nations.

In the first phase of the PACE programme, contributors will identify and supply suitable information on prevention and control, predominantly focused on videos, other visual materials, case-studies and well-presented written guidelines. The PACE Steering Group will identify important gaps in the available information. This identification of gaps in knowledge will hopefully influence the direction of research and investigations in the field of prevention and control of hazards in the work environment. Information on projects currently in progress will be collected and disseminated in order to encourage collaboration and avoid duplication.

Communication is a key element of the PACE programme. PACE will provide a mechanism for communication between providers and users of information. In order to allow for rapid and efficient communication, it is proposed to use computer technology, including electronic mailing where available.

In the first instance, the main activity is the establishment of an inventory of obtainable material. The technical information is to be targeted at professionals in the field of occupational hygiene, health and safety. These professionals will further disseminate relevant knowledge, information and material to others who may be influential in the design of processes and plants, or in the selection and implementation of control strategies. This latter group includes employers and workers. Different levels of information will be selected to meet the needs of each target audience.

Although initiated by WHO, it is proposed that the PACE programme be implemented in close collaboration with other international agencies including the United Nations Industrial Development Organization (UNIDO), the International Labour Office (ILO), the United Nations Environment Programme (UNEP) and the European Commission (EC), as well as the International Programme on Chemical Safety (IPCS - a joint programme by WHO, ILO and UNEP). Some highlights of the work of other international organizations, either in, or relevant to, the field of hazard prevention and control in the workplace, are presented in Annex III. In view of the close links between hazard prevention and control in the workplace and environmental protection, WHO activities, outside the Office of Occupational Health, concerning the environment are also presented in Annex III.

Ways and means to make this a joint programme of relevant international organizations, according to their respective mandates, are being sought. WHO Collaborating Centres for Occupational Health and other relevant national institutions, as well as non-governmental organizations, such as professional associations, are invited to actively participate in this programme.

The PACE strategy includes the identification/preparation of educational material and the creation of a recommended list of publications for a bookshelf on prevention and control. Implementation of training activities is to be promoted and facilitated wherever needed and requested, including the identification of fellowship possibilities. An important resource to be used is constituted by retired professionals willing to maintain momentum in the dissemination of knowledge and information.

Initial PACE activities

A number of tasks and activities to launch and maintain the PACE programme were agreed upon. These activities will be coordinated by a Steering Committee, initially selected from those attending the inaugural meeting at WHO, Geneva, from 19 to 21 September 1994 (Annex II). The key tasks are:

- Identification and supply of *suitable* information;
[The purpose is to maintain a list or inventory of suitable materials rather than creating a reference library.]
- Identification of *key documents* to be translated;
- Identification of organizations willing to assist in *translation*;
- Development of *instructions* for those who are going to use the materials;
- Identification of *partners* at the national and international levels;
- Preparation of *funding proposals*;
- Identification and preparation of *educational material*.
[Work has already started in this area with the first video on "Visualization of the Efficiency of Control Measures", and the first draft of a manual on "Hazard Prevention and Control in the Work Environment - Chemicals".]

Participation and Funding

The provision of financial support is critical to the success of the PACE programme. WHO will endorse and coordinate well-defined, specific proposals which address particular elements of the core programme. Support for PACE in the form of participation and/or funding is equally welcome.

The range of potential sponsors or funding agencies includes:

- National Work Environment Funds;
- WHO Collaborating Centres;
- National Occupational Hygiene and Safety Societies;
- Trade Unions;
- International and Regional Banks for Development;
- Employers' Associations and Commercial Companies;
- Governmental Agencies;
- Non-governmental organizations including the International Occupational Hygiene Association (IOHA) and the International Commission on Occupational Health (ICOH); and
- Other international organizations

IV - RECOMMENDATIONS

IV. 1 For the Governmental Level

If the health of workers is to be adequately protected and promoted, there needs to be political will at the governmental level. It is at this level that primary prevention starts to be promoted, through legislation and adequate programmes for enforcement, as well as for the development of the required human resources.

Legislation

In order to be effective, legislation must be enforced and applicable to the context in question. It should be said, however, that even in countries where good legislation exists, hazardous working conditions are still encountered which clearly demonstrates that the existence of legislation is no assurance for good working conditions.

There must be clear understanding on the part of those persons who may influence legislation, that:

- risk assessment and the adoption of occupational exposure limits, although essential for risk management, do not stand alone but are part of a broader set of procedures which **must** include the implementation and maintenance of control measures in the work environment;
- standards and regulations, if not enforced, are meaningless for the protection of workers' health, and their enforcement is not achieved only by monitoring, but also requires control interventions;
- the protection of workers' health and of the environment must start much earlier than it usually does, through "anticipatory preventive action", which should include:
 - occupational and environmental health impact assessments, prior to the design and installation of any new facility (industry, energy production, agriculture and food production, services);
 - selection of the most suitable and safest (least hazardous as well as least polluting) technology, as well as environmentally appropriate location;
 - proper design, with the required control technology as an integral part of the project, including provisions for safe handling and disposal of the resulting effluent and waste;

- elaboration of guidelines and training on the correct operation of processes, including on safe work practices and emergency procedures;
- creation of an effective joint health and safety structure involving workers and their representatives.

Still concerning legislation, one drawback encountered in many countries is that the legal requirement for implementation of controls puts a condition such as "..... as far as economically feasible", or "..... adapted to the financial status of the enterprise", which makes it easy, in many cases, to justify a complete absence of the required control for health protection.

Programmes and Training

The implementation of well-planned occupational health and occupational hygiene programmes is essential, with clear objectives, adequate resources and efficient management. There should be a balance among all aspects of anticipation, recognition, evaluation and control of health hazards in workplaces. Prevention and control should be given their due importance; it may sometimes be necessary to change the classical concept of "recognition-evaluation-control" to "recognition-control-evaluation", if facing recognized health hazards, particularly if exposure assessment capabilities are limited, and necessarily if exposure assessment capabilities are non-existent. In fact, in certain countries, there is legislation requesting that obviously hazardous operations (e.g. sandblasting, electroplating, degreasing, welding) be controlled before quantitative evaluations are carried out, even if capabilities for such do exist.

Moreover, coordination with related activities, such as accident prevention and environmental protection, are indispensable.

Specialized professionals and multi-disciplinary teamwork are needed for the design and implementation of appropriate control strategies. Therefore, adequate training of occupational hygienists, at university level, should be established and/or promoted.

IV. 2 Institutional level

In order to decrease the "knowledge-application gap" in the field of hazard prevention and control, more action is needed particularly concerning information and training.

Therefore, in occupational health and other institutions dealing with the work environment (both governmental and non-governmental), more emphasis should be placed on activities aiming at primary prevention. This refers to the development of new knowledge, application of existing knowledge to actual workplace situations, training activities and information exchanges. This requires the assignment of human and financial resources specifically for this purpose.

Applied research on pragmatic solutions for the prevention of occupational hazards should be promoted.

Institutions providing occupational health and occupational hygiene services to industry should emphasize the need for primary prevention, even when their main service is monitoring.

IV. 3 Workplace Level

Management

Management should be aware that:

- workers have a basic right not to have their health and safety threatened by their work and that it is the responsibility of management to ensure a healthy and safe work environment;
- the protection of workers' health is a positive point as it brings, not only health, but also, financial benefits;
- "prevention" is more important than "monitoring", and the cost to control is not necessarily higher than the cost of monitoring;
- competent professionals and teamwork, involving all concerned persons, are indispensable.

Workers and Unions

Workers should be aware that:

- health is priceless;
- hazards should be known and controlled;

- collective bargaining must include health and safety.

At the workplace there should be awareness of potential hazards and their consequences, and either:

- knowledge and experience to effectively deal with their control, or,
- possibility to obtain assistance from professionals experienced in the design and implementation of control measures.

IV.4 Occupational Health and Hygiene Professionals and Professional Associations

These should:

- understand the need for a multi-disciplinary approach in occupational health, having occupational hygiene as one of the essential components;
- understand that procedures, such as biological monitoring and health surveillance, are useful complements to control strategies since they contribute to detect exposures, or the consequences of exposures, but that they do not "per se" prevent exposures;
- further promote occupational hygiene training at a high level, with correct emphasis on hazard prevention and control;
- intensify international cooperation in support of national efforts to attain appropriate levels of professional competence in occupational health, hygiene and safety (for example, through certification programmes), and to encourage individuals to maintain the highest possible standard;
- promote the legislation needed for the official recognition of the required occupational health professions (e.g. occupational hygiene).

IV. 5 International and Donor Agencies

When priorities for action and funding are established, due importance should be given to projects aiming at the promotion of primary prevention ("problem-solving projects"), which should be developed alongside "fact-finding" projects (e.g. epidemiological studies, setting up of analytical laboratories, training in measuring techniques) to ensure a comprehensive approach. It should be said that "fact-finding" studies have important roles as the basis for preventive actions and as tools to monitor

their efficiency, but only these preventive actions will actually protect the health of workers and the environment.

International collaboration should be emphasized to enhance on-going efforts and avoid duplication. International organizations, such as WHO, ILO, UNIDO, UNEP, EC, could play an important role in the transfer and dissemination of knowledge on control measures and should allocate human and financial resources to create and support an international network in this field.

IV. 6 General

All concerned should promote greater access to reliable information on strategies and technology for the control of occupational and environmental hazards, and increased use of the available sources, including institutions and agencies, publications, audio-visual material and databases, as well as the creation and/or utilization of relevant networks.

In decisions related to occupational health and safety, at different levels, the principles of the ILO Conventions and Recommendations, adopted by the International Labour Conference in a tripartite consensus, should be considered, in particular those of the following basic Conventions:

- the Occupational Safety and Health Convention, 1981 (No.155) and Recommendations, 1981 (No.164), which provide for the adoption of a national occupational safety and health policy and describe the actions needed at the national and enterprise levels to promote occupational safety and health and to improve the working environment, and,
- the ILO Occupational Health Services Convention, 1985 (No.161) and Recommendations, 1985 (No.171), which provide for the establishment of occupational health services which will contribute to the implementation of the occupational safety and health policy and will perform their preventive functions at the enterprise level.

All decision makers should keep in mind that we are all concerned by occupational health, environmental and sustainable development issues and that "our decisions of today will determine the quality of life in this planet tomorrow".

**CONSULTATION ON "HAZARD PREVENTION AND CONTROL
IN THE WORK ENVIRONMENT"
WHO, Geneva, 19-21 September 1994**

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WHO PACE PROGRAMME - COLLABORATION WITH OTHER ORGANIZATIONS AND PROGRAMMES

1. Related Activities in other International Agencies

The United Nations Industrial Development Organization (UNIDO) has many ongoing projects in promoting user/environment-friendly technology. In this, the organization practically covers all industrial sub-sectors and promotes integrated safety which includes plant/process Safety, Health and Environment (SHE aspects). Technology assessment, waste minimization, cleaner production (in collaboration with UNEP), risk reduction in chemical production and use (including pesticides), are given major thrust for sustainable industrial development. National, regional and global networking is given great priority for exchange of information, experience and discussions. UNIDO database, INTIB (Industrial and Technological Information Bank) covers various aspects related to information on technology for exchange of information worldwide.

The mandate of the International Labour Organization (ILO) is to raise standards of living worldwide, to promote social justice and reform, and to seek adequate protection for the life and health of workers in all occupations. The ILO works towards these goals by setting international labour standards in the form of Conventions which are supplemented by Recommendations, by promoting research, and by providing technical assistance to Member countries. The Organization has a tripartite structure in which representatives of labour, employers as well as governments participate in the decision making process at all levels. The activities of the ILO's International Programme for the Improvement of Working Conditions and Environment (PIACT) conducted through the Working Conditions and Environment Department, contribute to hazard prevention and control in the work environment. A large number of ILO Conventions and Recommendations deal with occupational safety and health matters. They usually stipulate provisions concerning the establishment of a national policy and actions at the national and enterprise levels for its implementation, including preventive and protective measures; responsibilities of employers; rights and duties of workers and information and training. During the last 15 years, Conventions and Recommendations were adopted on occupational safety and health, occupational health services, safety in the use of asbestos and chemical safety, safety and health in construction and in mines, as well as on the prevention of major industrial accidents. Specific guidelines are provided in Codes of Practice, mainly on the same subjects dealt with in Conventions, and in technical publications.

Assistance is provided by the ILO for the development and promotion of international labour standards and the formulation and implementation of appropriate national policies and programmes. Priority is given to technical advisory services, organizing activities related to particularly hazardous occupations and designing and implementing enterprise-level promotional programmes.

Training and technical assistance activities promote the implementation of international labour standards, with a view to strengthening the national regulatory infrastructure. They also aim at enhancing safety and health institutions and the national capacity to provide training and information services on occupational health related issues.

"Environment and the world of work" is one of the five key themes for the ILO's 1994-95 programme period (the others are: international labour standards and the defence of human rights, equality for women, employment promotion and structural adjustment, the rural and informal sectors). In the context of this priority element, the ILO collaborates with the other organizations mentioned in this paper. Recognizing that many hazards do not stop at the factory fence, the ILO works with individual agencies on a project-by-project basis, maintains on-going relations with a number of them through such activities as the International Programme on Chemical Safety and the WHO/ILO Joint Committee on Occupational Health, and carries out its own programme, which includes the Interdepartmental Project on Environment and the World of Work as well as the Safety and Health Information Services Branch (SIS) of the Working Conditions and Environment Department.

SIS is home to the International Occupational Safety and Health Information Centre (CIS)*, which was organized in 1959 to collect and disseminate information that would contribute to the prevention of accidents and diseases in the workplace. Its bibliographic references now number 45,000. They have been available through public data networks for over ten years, CIS has engaged in capacity-building projects that have enabled appropriate institutions in many Member States to access a broad range of electronic sources, including those of the ILO. CIS has national focal points in 70 countries, developing and industrialized; several of these provide access to data from CIS and other sources at the national and regional levels.

Another major activity of SIS is the compilation and publication of the Fourth Edition of the **ILO Encyclopaedia of Occupational Health and Safety**. The first volume of this popular reference will appear in print at the end of 1995, with a CD-ROM edition to follow in 1996. Several WHO staff members figure among the contributors.

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The United Nations Environment Programme (UNEP), Industry and Environment Cleaner Production Programme has a number of information transfer activities which include: publications, training and technical assistance, and the International Cleaner Production Information Clearinghouse (ICPIC). ICPIC contains information that explains and illustrates the cleaner production concept. The current on-line system has been abandoned for a diskette version which will be updated regularly, and selected information will be made available in hardcopy format. An Internet link to the Programme will also be established.

In the area of publications, the Programme has produced a number of successful documents; "Cleaner Production Worldwide", and "Cleaner Production in the Asia Pacific Economic Cooperation (APEC) Region", for example, that provide examples of cleaner production applications throughout the world. Guidance documents, such as "Government Strategies and Policies for Cleaner Production", provide assistance to governments to develop cleaner production activities.

Having regard to proposals from the European Commission (EC), the Council of the European Union has adopted a large number of Directives addressed to the Member States to improve the safety and health of workers at work. Several of these Directives require the employer to implement measures for hazard prevention and control at the workplace.

The International Programme on Chemical Safety (IPCS)* produces a number of relevant documentary outputs, including Environmental Health Criteria (EHC) monographs assessing the risks of chemicals, groups of chemicals, physical agents, or describing principles and methods for evaluating toxicity related to systems and organs, Health and Safety Guides (HSG), International Chemical Safety Cards (ICSC) produced in collaboration with the European Commission, which are both targeted to worker health and safety, Data Sheets on Pesticides, Safety Evaluations of Food Additives and Contaminants, Pesticide Residues, and Veterinary Drug Residues (jointly with FAO), and Poison Information Monographs (PIM). The WHO/FAO Joint Meeting on Pesticides has a subsidiary Panel dealing with public health and occupational health aspects of pesticide use, including guidance on occupational exposure limits and safety precautions.

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2. Related Activities in other WHO programmes

The Office of Global and Integrated Environmental Health has initiated the Global Environmental Health Networks. The goal of the Networks is to strengthen education, research and training in environmental health in order to increase the capacity of developing countries to deal with environmental problems, including occupational health. The Networks function by linking professionals working in the environmental health field with each other, WHO and other resources. Three Networks have been initiated:

- (1) The Global Environmental Technology Network (GETNET)
- (2) The Global Environmental Epidemiology Network (GEENET)
- (3) The Global Environmental Library Network (GELNET)

The principles of GETNET and GEENET are similar, network building, information exchange, training, development of training material and promotion of research. GETNET provides support and information on issues related to environmental management, whereas GEENET provides information on issues related to environmental epidemiology.

GELNET was created to facilitate the availability of information for GETNET and GEENET members and other health professionals.

The WHO Office of Urban Environmental Health (UEH), with support from UNEP, carries out the Global Environmental Monitoring System (GEMS) with four components, namely, Air, Water, Food and Radiation.

GEMS/Air incorporates 50 countries and 86 cities in different parts of the world, with the following objectives:

- (1) coordination of a global air pollution monitoring network in megacities;
- (2) development of appropriate methodology;
- (3) preparation of assessments;
- (4) provision of technical support and training; and
- (5) initiation of special studies.

GEMS/Water addresses global issues of water quality through a network of monitoring stations in rivers, lakes, reservoirs and groundwaters on all continents. By 1990, 344 active monitoring stations were operating in 42 countries.

Long-term objectives are as follows:

- (1) To provide water quality assessments of the world's fresh water;
- (2) To provide information and assessment of the fluxes of toxic chemicals, nutrients and other pollutants from major river barriers to the continent/ocean interfaces; and
- (3) To strengthen national water quality monitoring networks in developing countries through training, improvement of analytical capabilities and data quality assurance.

Another WHO/UEH activity is the provision of health guidelines and strategies for the safe use of treated, waste water for agriculture and aquaculture. This includes domestic as well as industrial waste waters.

"Healthy Cities", another relevant programme being developed under the leadership of WHO, aims at improving living and working conditions in cities. The Healthy City Programme aims to improve environment and health conditions by raising awareness, and by mobilizing community participation in partnerships with local (municipal) agencies and institutions, thereby improving their capacity to deliver effective environmental and health services. A priority objective is to develop the role of local governments in public health and to encourage them to implement a "Health for All" policy at city level.

Many workplaces, particularly small enterprises, are located in urban areas; therefore the conditions in the work environment and its surroundings are a key concern of the "Healthy Cities Programme".